Vegetation Resources Inventory

Guidelines for Preparing a Project Implementation Plan for Ground Sampling

Prepared by
Ministry of Sustainable Resource Management
Resource Information Branch
For the Terrestrial Ecosystems Task Force
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Executive Summary

The Ministry of Sustainable Resource Management (MSRM) Resource Information Branch (RIB) has developed a business planning process to ensure the successful implementation of the Vegetation Resources Inventory (VRI) ground-sampling and photo-interpretation projects. This process includes the preparation of VRI Strategic Inventory Plans (VSIPs) and Project Implementation Plans (VPIPs).

This document provides guidance to stakeholders responsible for preparing the VPIP for the ground-sampling projects. (Guidelines for preparing the VPIP for photo interpretation are presented in a separate MSRM report entitled *Vegetation Resources Inventory, Guidelines for Preparing a Project Implementation Plan for Photo Interpretation.)*

The VPIP is a working document that details the specific operational activities associated with implementation and documentation of the inventory project. It identifies the project geographic areas, priorities, plot location coordination, inventory costs by year, and roles and responsibilities for implementation.

Prior to initiating a VRI project, VPIP must be completed to the general standards outlined in this document. The document is reviewed and signed-off by the MSRM to ensure the appropriate technical standards are being followed and by the MoF to ensure the final products will meet the business application

Acknowledgments

The Government of British Columbia provides funding of the Resources Information Standards Committee work, including the preparation of this document. The Resources Information Standards Committee supports the effective, timely and integrated use of land and resource information for planning and decision making by developing and delivering focussed, cost-effective, common provincial standards and procedures for information collection, management and analysis. Representatives to the Committee and its Task Forces are drawn from the ministries and agencies of the Canadian and the British Columbia governments, including academic, industry and First Nations involvement.

The Resources Information Standards Committee evolved from the Resources Inventory Committee which received funding from the Canada-British Columbia Partnership Agreement of Forest Resource Development (FRDA II), the Corporate Resource Inventory Initiative (CRII) and by Forest Renewal BC (FRBC), and addressed concerns of the 1991 Forest Resources Commission.

For further information about the Resources Information Standards Committee, please access the RISC website at: http://srmwww.gov.bc.ca/risc/

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Introduction

The Ministry of Sustainable Resource Management (MSRM) Resource Information Branch (RIB) has developed a business planning process to ensure the successful implementation of the Vegetation Resources Inventory (VRI) ground-sampling and photo-interpretation projects. This process includes development of VRI Strategic Inventory Plans (VSIPs) and Project Implementation Plans (VPIPs). This report provides guidelines that can be used to prepare a VPIP for the ground-sampling projects. Guidelines for the preparation of a VPIP for photo interpretation are available in a separate MSRM report entitled *Vegetation Resources Inventory, Guidelines for Preparing a Project Implementation Plan for Photo Interpretation*. The intent is that these guidelines will assist proponents in developing a VPIP and streamline the administration of the VRI planning process. Examples of completed VPIPs are also available on the RIB web site. VRI Planning.

VRI Planning

The MSRM RIB has developed a business planning process for VRI photo interpretation and ground sampling projects. The VRI planning process involves developing VSIPs and VPIPs that identify resource-specific management issues, desired inventory products and activities, and priorities. A VSIP broadly outlines the VRI activities and products needed to address the identified forest management issues. The VPIP identifies the operational project details.

Forest industry proponents are responsible for developing all phases of the VRI planning process (VSIPs and VPIPS). The MSRM is responsible for developing minimum standards for the planning of VRI projects, data capture and audit. In addition, the MSRM is responsible for reviewing VPIPS to ensure the information is being collected to known standards, while the MoF is responsible to provide a review of the plan to ensure that their business needs have been addressed. These plans must be signed-off by MSRM and MoF.

The VPIP more specifically identifies the needs for VRI management inventories and provides the details for implementation of the VRI in terms of geographic areas, scheduling, priorities, plot location coordination, estimated inventory costs by year, and roles and responsibilities.

Project Implementation Plan Guidelines

The following sections present document and outline the guidelines for preparing a VRI Project Implementation Plan (VPIP) for a management unit ground sampling project. *Text in Italics provides examples for section content.*

Introduction and Background Information

Briefly describe the VRI process.
Briefly describe the state of the current inventory (quality, age, etc.).
Describe the information needs (Timber Supply Review, habitat mapping, etc.).
Describe how the ground sampling fulfills the information requirements.

Document Objectives

Describe the objectives of the VPIP document.

This report outlines the sampling plan for collecting inventory data to improve the available information for all vegetated treed stands within the XXX Forest District.

Landbase

Describe the landbase in terms of geographic area, forest types, and administrative zones. Include summary tables.

Assess the quality of the existing landbase inventory in terms of:

- coverage: TSA, TFL, Parks, private land.
- age: year of the photos used in photo-interpretation.
- data availability: digital formats.

The XX Forest District total area is 578,118 ha, of which 311,321 ha contribute to the timber harvesting land base.

The existing inventory was completed in 1995 using 1993 colour aerial photography. This inventory covers the TSA land base; parks and private lands are not included in the current inventory.

Ground Sampling Plan

Sampling Objectives

Define the objectives of the ground-sampling inventory.

The objective of this inventory is to:

Install an adequate number of VRI sample clusters to adjust the timber inventory in the District Vegetated Treed (VT) areas to achieve a sampling error of ±10% (95% probability).

Target Population

Define the target population for the proposed inventory in terms of stand type, geographic locations, stand attributes, etc. If areas that meet the target population definition are not being included in the inventory (parks, private, IR), discuss the rationale for their exclusion. Discuss the repercussion of excluding these areas from the population and provide areas for both the total population and the strata within.

The target population for this inventory includes all vegetated treed polygons within the operable land base of the XXX Forest District.

Sample Size

Set a sample size for ground sampling. Include a description of how the sample size was set, including the target sampling error (SE%), the estimated coefficient of variation (CV), and the source. Include a table showing the total area of the intended population, the strata areas, the number of samples per strata, and the number of hectares each sample is to represent. A footnote should also be included indicating that these numbers are subject to change, following the selection of samples, and completion of the ground sampling, and that the final analysis documentation will contain the actual areas and numbers of samples completed by strata. *See appendix C for further information regarding the determination of sample size.*

An estimated total of XXX sampling points are suggested for planning, training, and other logistic considerations. This total sample size was estimated using a CV of 90% (these stand types tend to be relatively heterogeneous) and an anticipated sampling error of ±10% (95% probability) for net timber volume.

Sampling Selection

Describe how the samples will be selected. Indicate the data source for sample selection (file version/date/archive the sample selection files) and polygon selection criteria.

All the potential vegetated treed polygons within the XXX Forest District will be identified in the VIF database and assembled into a list using the PPSWR sample selection standard. The polygons will be stratified according to the three leading species types.

The XXX sample polygons were selected in batches of XX to allow for multi-year sampling. This approach to sample selection means re-visiting portions of each stratum more than once. However, it means that a preliminary sampling error can be calculated after the first batch is complete, and the sample size can be adjusted in the following year to achieve the sampling objective.

The spatial and attribute files used for the sample selection will be submitted to RIB in an acceptable format.

Sampling Approach

If the sampling will occur over several years, describe how sampling will be implemented and how plots will be distributed between the field seasons.

This inventory will be achieved in two steps. Step 1 is to complete a statistically valid sample of the area that will include 65 timber emphasis sample plot clusters. Step 2 will be to complete the remaining samples. Step 1 will be completed in the fall of XXXX and spring of XXXX. The additional sampling in Step 2 will be completed in the summer and fall of XXXX.

Sample Type

Describe the chosen sampling type for the inventory.

The ground sampling for this inventory will use Timber Emphasis Plots (TEPs). This sampling will include call grading, net factoring, and sub-sampling trees for stem analysis to address decay and waste issues, not breakage. This sampling also will include sub-sampling YYY trees to assess attributes such as bole straightness and length to first branch or crook, which affect YYY merchantability.

Measurements

Describe the measurements for each attribute. The selected measurements should conform to existing minimum standards.

These measurements will be recorded using the VRI Card Types 1 – 3 and 8 – 1. All current VRI ground sampling standards will be followed. (VRI Ground Sampling Procedures Version 4.3)

The digital data will be submitted to RIB in an acceptable format.

Supporting Activities

Describe the supporting activities for the ground sampling. These include Net Volume Adjustment Factor (NVAF) sampling and may include Within Polygon Variation (WPV) sampling. Describe how these sampling activities will be implemented in the District or sub-unit.

NVAF sampling will be conducted after the second field season. XX trees will be selected from the complete tree list compiled during ground sampling. Sampling will be conducted according to the NVAF and ground sampling procedures manuals.

The digital data will be submitted to RIB in an acceptable format.

Project Implementation

Scheduling

Outline in detail the activities needed to implement the project.

Step 1 – Year 1

1. *Assemble all polygons in the District into one list. Check to ensure no areas are missing or double counted.*
2. *Sort the polygon list according the defined criteria using the PPSWR sampling methodology.*
3. *Archive all attribute and graphic files (mapsheet/version number) used in the sample selection and ground sample location phases of the project.*
4. *Systematically select the number of sampling points (e.g., 120) from the list of potential sampling points. The sample selection process is described in the MSRM RIB document Vegetation Resources Inventory Sample Selection Procedures for Ground Sampling Version 3.3- December 2002. In the event that additional sampling may be required at a later date, an additional number of sample points may be chosen to augment the original sample list.*
5. *Select a valid sub-sample of polygons for NVAF sampling.*
6. *Begin planning for field sampling.*
7. *Prepare a field-sampling plan that includes plot batches (e.g., two batches of 25 plots each), to ensure a complete unbiased sample is obtained at the end of the field season. Identify NVAF sample points and ensure they are sampled early in the field season. Monitor the area to ensure that no logging of the sample plots occurs before the second season of sampling is complete.*
8. *Locate and measure VRI sample clusters in the first two batches of the selected sampling points. Arrange for check cruisers to sample the NVAF samples. Prepare a tree-sampling matrix, select the sample trees, and conduct stem analysis.*
9. *Carefully monitor quality assurance of field data and procedures during field sampling.*
10. *Compile the data from completed batches in the winter. This will include computing averages of net timber volume, regression of photo-estimated volume to ground-sample volume, and the associated standard error of the regression.*

Step 2 – Year 2

11. *Prepare for the second step. This will include calculation of the CV based on the standard error of the regression for net volume. The remaining number of samples required to achieve the stated desired precision can then be accurately determined using standard procedures.*
12. *Systematically select the last batch of sample clusters from the remaining samples in the initial list of the potential sampling points.*
13. *Locate and measure remaining ground sampling sample. Complete stem analysis of the NVAF sample trees.*
14. *Compile all data and produce final inventory results. Begin planning the WPV sampling.*

The following chart provides an example of the two-step process (Figure 2).

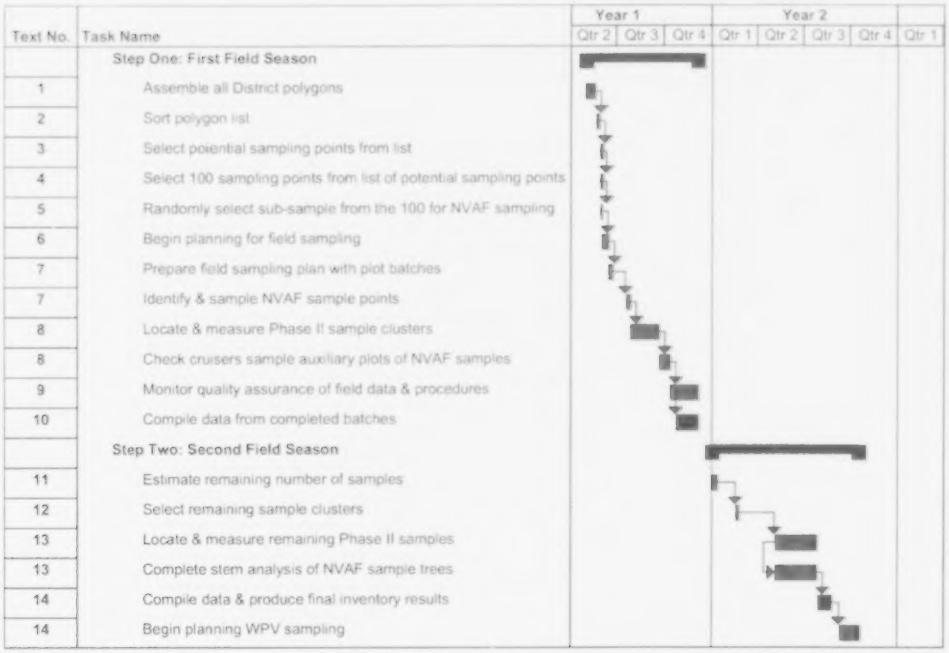
Text No.
Task Name
Year 1
Year 2
Qtr 2
Qtr 3
Qtr 4
Qtr 1
Qtr 2
Qtr 3
Qtr 4
Qtr 1
Step One: First Field Season
1 Assemble all District polygons
2 Sort polygon list
3 Select potential sampling points from list
4 Select 100 sampling points from list of potential sampling points
5 Randomly select sub-sample from the 100 for NVAF sampling
6 Begin planning for field sampling
7 Prepare field sampling plan with plot batches
7 Identify & sample NVAF sample points
8 Locate & measure Phase II sample clusters
8 Check cruisers sample auxiliary plots of NVAF samples
9 Monitor quality assurance of field data & procedures
10 Compile data from completed batches
Step Two: Second Field Season
11 Estimate remaining number of samples
12 Select remaining sample clusters
13 Locate & measure remaining Phase II samples
13 Complete stem analysis of NVAF sample trees
14 Compile data & produce final inventory results
14 Begin planning WPV sampling

Figure 1 - An example Gantt chart of the two-step inventory implementation process.

Sample Packages

Describe the standards used and contents of the sample packages.

Field sample packages will be prepared following VRI methodology. Maps will be plotted showing the VRI grid overlays and selected sample locations.

Roles and Responsibilities

Project Coordinator

The project coordinator must be identified to indicate who is managing this project. The responsibilities of the project coordinator must be stated.

The project coordinator will be XXX Consultants Ltd., and their role will include:

- coordinating the project;
- monitoring and communicating project progress;
- ensuring all contractors are qualified and certified;
- overseeing ground-sampling activities;
- ensuring quality assurance is complete; and
- assisting in coordinating technical expertise where required.

Project Support

Indicate who is responsible for providing the following:

- field supplies such as aluminum stakes, cards, etc. (how much and when required);
- technical support for GPS work;
- the sample list; and
- sample packages including compiling field maps, photos, and grids.

Fieldwork

Indicate the standards the fieldwork will follow. Indicate who is expected to complete each component of fieldwork:

- Ground sampling;
- NVAF; and
- WPV.

Quality Assurance

Indicate who is expected to complete the quality assurance, when, and by what minimum standard.

A sub-contractor will conduct quality assurance in late summer XXXX. The VRI quality assurance standards require inspection of at least 10% of the samples.

Data Compilation, Analysis and Adjustment

Indicate who will be completing each component listed below, and include timelines for each component:

- data compilation;
- data entry;
- statistical analysis; and
- inventory file adjustment.

Data compilation will be completed based to the VRI compilation standard. Data entry and analysis will be completed after each field season. New CVs will be calculated from the first field season and used to adjust the following year's sample size. All tree level information will be supplied to RIB.

The database (individual-polygon) adjustment will be done by the XX after all sampling is completed. The analysis will follow the minimum standards as stated in the "VRI Inventory Attribute Adjustment Procedures Version 4.4 DRAFT."

Ground sample and adjusted inventory digital data will be submitted to RIB in an acceptable format.

Sample List

Include a complete sample list, and a comparison of the sample and population, as per the sample selection standards.

Sign-off Sheet

Include a sign-off sheet prior to submitting the proposal to the appropriate funding review source. (Price Waterhouse Coopers).

Approval/Signoff of VPIP.

I have read and agree that the procedures outlined in this proposal meet current MSRM minimum standards.

_____

Manager, Vegetation Resources Inventory *date*
Resource Information Branch, MSRM.

I have read and agree that the activities and products outlined in proposal will meet MoF business needs.

_____

Manager, Development and Policy, Timber Supply Branch, MoF. *Date*

Appendix A: Glossary of Terms

Ground Sampling

Ground sampling is the field measurement of timber, ecology, range, and/or coarse woody debris values at one or more locations within each sample polygon. The sample polygons are selected proportional to their area from a sorted list. To accommodate the wide variety of resources, various types and sizes of sampling units (e.g., fixed and variable plots, transects) are used to make the measurements.

Inventory Unit

An inventory unit is the target population from which the samples are chosen. For management inventories, the inventory unit is usually a TSA or TFL.

Land Cover Classification

The BC Land Cover Classification Scheme (BCLCCS) was designed specifically to meet the requirements of the VRI, in addition to providing general information useful for "global vegetation accounting" and "integrated resource management." The BCLCCS is hierarchical and reflects the current state of the land cover (e.g., presence or absence of vegetation, type and density of vegetation) and such fixed characteristics as landscape position (i.e., wetland, upland, alpine). There are two main classes of polygons: Vegetated and Non-Vegetated.

Management VRI

Management VRIs are specialized inventories that provide more detailed information required for specific resource management, i.e., day-to-day forest management. One or more VRI sampling procedures may be used for management inventories. Management inventories may focus on specific resource types (timber, range, ecology), geographic areas (e.g., landscape unit, operable areas etc.), and attribute sets (e.g., Douglas-fir leading stands, age class 4+). They may use one or more of the following tools: photo-interpreted estimates, ground sampling, and NVAF sampling.

National Forest Inventory (NFI)

The NFI provides information on Canada's resources across all provinces and allows the Federal Government a consistent framework for reporting on Canada's inventory. The inventory unit for the NFI is the entire country, although it is implemented province-by-province.

Net Volume Adjustment Factor (NVAF) Sampling

NVAF sampling provides factors to adjust net tree volume from the ground sampling, where net tree volume is estimated from the VRI net factoring process and taper equations. The factors account for hidden decay and possible taper equation bias. Sampling involves detailed stem analysis of sample trees to calculate actual net volume. The actual net volume is compared to the estimated net volume.

Photo Interpretation

Photo-interpretation involves the subjective delineation of polygons and the photo estimation of attributes for all polygons in an inventory unit. Medium scale aerial photographs (1:15,000) are most often used in the photo-interpretation process. However, if the existing photo-based inventory is acceptable, the database can be translated into VRI format and upgraded to include the additional VRI attributes.

Post-Stratification

Post-stratification involves the division of an inventory unit into mutually exclusive sub-populations (strata) *after* ground sampling has been completed. Samples that fall in each post-stratum are analyzed separately, and the results may be applied to the corresponding population post-strata to improve the precision of the inventory's overall averages and totals. In the VRI, these strata (leading species) are usually pre-defined in the sample selection phase.

Pre-Stratification

Pre-stratification involves the division of an inventory unit into mutually exclusive sub-populations (strata) *before* ground sampling to provide estimates for specific areas, or to increase the confidence in the overall estimates by considering the special characteristics of each stratum.

Resource-Specific Interpretations

Resource-specific Interpretations (RSI) utilize the RISC standard VRI baseline data products, in combination with other data sources and analysis (outside of that required to produce the VRI), to produce information to address specific-resource management issues (e.g., TSR review, important ecosystems, important habitats). These interpretations include ecosystem interpretations and habitat interpretations.

Sample

A set of sampling units.

Sample Size

The sample size for an inventory is the minimum number of ground samples to be established in an inventory unit to meet the target precision.

Sampling Unit

A sampling unit is a portion of the population from which sample observations are made. Sampling units are non-overlapping subdivisions of the population for sampling purposes.

Statistical Adjustment

Statistical adjustment is the process of adjusting the values of the photo-interpreted variables using the ground sampling observations. For each sampled polygon, the ground observations are compared to the photo-estimated values to develop an adjustment factor. This factor is

then applied to all polygons in the photo-interpreted database to produce the final adjusted database.

Sub-unit

The term sub-unit describes the inventory unit of a management inventory. A sub-unit may be defined by a specific geographic area (e.g., operable landbase) or stand type (e.g., problem forest types) within the Forest District.

Target Population

The population of interest from which samples are drawn; see also Inventory Unit.

Target Precision

Target precision expresses the amount of variation in key attributes (e.g., timber volume) desired in the final results. The target precision, usually expressed as the coefficient of variation (CV), is used to calculate the minimum sample size for subsequent ground sampling.

Vegetation Resources Inventory (VRI)

The VRI is the MSRM standard for assessing the quantity and quality of BC's vegetation resources. The VRI process is designed to include a flexible set of sampling procedures for collecting vegetation resource information. The VRI is essentially a toolbox of procedures, which include:

- *Photo Interpretation*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground Sampling*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes.
- *NVAF Sampling*: Stem analysis sampling of individual trees for net volume adjustment.
- *WPV Sampling*: Intensive sampling of selected polygons to determine the error between the estimated attribute values and the "true" attribute values.
- *Statistical Adjustment*: the adjustment of the photo-interpreted estimates for all polygons in an inventory unit or management unit using the values measured during ground sampling.

The VRI can be deployed over a management unit measuring selected resources in specific portions of the landbase. The VRI sampling process produces spatial and non-spatial databases that can be used in multiple resource management applications including timber, ecosystem, and wildlife habitat management.

Within Polygon Variation (WPV) Sampling

WPV sampling provides information for expressing the true individual polygon error, assessed as the difference between the adjusted polygon value and the "true" value for that polygon. The "true" value for the polygon is an estimate derived from a small sample of intensively ground-sampled polygons.

Appendix B: Best Practices for the Determination of Sample Size and Sampling Error for the VRI Ground Sample Inventories

The following information is to provide guidance to proponents considering the development of a VRI ground sample inventory.

Background:

The introduction of the Vegetation Resources Inventory (VRI) in 1992 provided an opportunity to review the existing standards (at that time) for inventory data collection, and to introduce higher levels of statistical rigor where virtually none existed before. During the implementation phase of the VRI, the issue of sampling error standards was reviewed. At that stage, the target sampling error standard for inventory audits was 15% at the 95% level of probability. Based on the analysis of various inventory audit results and their implication on inventory information usage, a need to revise the target sampling error standards was identified.

After a review process, the target sampling error standard was set at 10% at the 95% level of probability. Accordingly, in June 1997, the Chief Forester of the MoF approved an amendment to the minimum standard regarding target-sampling errors for timber volume for Vegetation Resources Inventory (VRI). MSRM has recommended the use of the 10% target sampling error, at the 95% level of probability since then. The experience gained between 1997 and now indicates that there is a need to exercise flexibility, to take into account the local business needs and to consider the cost of an inventory in choosing an acceptable target sampling error.

Target sampling errors are needed for management unit inventories to control the precision of the sampling process and gauge the accuracy of estimates generated from the sample. Generally stated, target-sampling errors are associated with levels of comfort based on historical trends, past experiences, and previous projects. While the more practical considerations of logistics and resources often over-ride statistical considerations, minimum target sampling errors are needed to guide the formal process of determining sample size for an inventory unit or sub-unit. This process involves anticipating the results of one attribute of interest (e.g., target-sampling error for timber volume) and then determining the approximate sample size that would meet the precision requirement for that attribute.

The 1997 target sampling errors used the 95% level of probability as the point of reference. This point of reference has a bearing on the cost of conducting an inventory, in that it affects sample size. This 95% level of probability was identified as a level that would allow the Chief Forester or statutory decision maker to be comfortable with the likelihood of making decisions with sample estimates that are in error. In practical terms, the risk of the confidence interval not enclosing the "true" population mean is 1 in 20. Lowering the probability level would increase the likelihood that an estimate is in error; for example, lowering it to 90% would mean that 1 in 10 estimates would be too far from the true

population mean. Allowing several different probability levels is also not logical since the TSR uses VRI estimates frequently, and it is logical to want some consistency in the errors that can be expected.

Flexibility in determining an appropriate and cost-effective sample size can be achieved by allowing some leeway in the total sampling error (one-half the width of the confidence interval) for an estimate while maintaining the desirable 95% level for the estimates.

The determination of selecting a suitable sampling error must occur during the business planning phase of a VRI ground sample inventory and be documented in VRI ground sample implementation project plan.

Options:

Best practices for target sampling error objectives are presented here. Sampling error objectives are not typically set for strata. These proposed guidelines are for net timber volume (close utilization net volume, net decay, waste and breakage). Three possible options are:

Option 1:

Use the historical standard where timber emphasis samples are required to have a sampling error of 10% for the primary vegetated treed population. If samples are designed to cover the entire land-base (e.g., vegetated treed / vegetated non-treed / non-vegetated), target a sampling error of 15% at the 95% level of probability:

Option 2:

While retaining the 95% probability level for estimates of precision (confidence intervals), allow flexibility in determining sampling error requirements on a project-by-project basis, depending on business needs, and the risks a user may wish to take to address local issues.

Guidelines for Preparing a Project Implementation Plan for Ground Sampling
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1. page 5	- **Supporting Activities** – replace the second sentence in paragraph one with 'These must include Net Volume Adjustment Factor (NVAF) sampling and may include Within Polygon Variation (WPV) sampling.'
2. page 11	- **Sign-off Sheet** – replace signatory title (Manager, Development and Policy, Timber Supply Branch, MoF.) with (Director, Forest Analysis Branch, MoF.)